

which timely warnings were issued beginning for the northwestern portion of the district on the morning of the 17th; they were extended over the interior of the district at 8 p. m. of the 17th, and to the Gulf Coast on the morning of the 18th. The temperatures predicted for the different parts of the district occurred almost exactly as forecast.

Moderate cold waves occurred over the northern portion of the district on the 21st, 22d, and 29th, for which warnings were issued. No cold wave occurred without warning.

Moderate storm winds occurred on some portion of the West Gulf coast on the 6th, 12th, 15th, 16th, 18th, and 19th. Warnings were issued for some portion of the coast as follows: Small-craft warnings on the 3d, 11th, 15th, 17th, 18th, 20th, and 21st; storm warnings on the 6th, 11th, 14th, 15th, and 18th. Warnings were issued for all storm winds except at Galveston and Port Arthur on the 6th.

Fire-weather warnings were issued for Arkansas and Oklahoma on the 3d, and for Arkansas on the 14th and 18th.—*I. M. Cline.*

DENVER FORECAST DISTRICT.

The month was cold and stormy, with an excess in precipitation in about all of the district, except the extreme southern portion.

On the morning of the 3d, when a disturbance of marked intensity was central over southeastern Colorado, warnings of heavy snow and much colder weather were issued to stockmen in eastern and southern Colorado and northwestern New Mexico. Light snow occurred throughout the region indicated, attended by a sharp fall in temperature that amounted almost to a cold wave.

Live-stock warnings were issued on the morning of the 9th to interests in southwestern Colorado, northwestern New Mexico, northeastern Arizona, and southern Utah, when heavy snow was expected to attend a low of considerable intensity that was central over southern Nevada. Moderately heavy snow occurred in southwestern Utah during the night of the 9th–10th, and light snow fell in the remainder of the region in which warnings were distributed.

A cold-wave warning was issued for north-central Arizona on the morning of the 10th. Although an area of decidedly low pressure which was central near Flagstaff moved rapidly eastward, a fall in temperature of only about 10 degrees occurred at that station.

Warnings of a moderate cold wave, issued on the 14th for southwestern Colorado, extreme northwestern New Mexico, northeastern Arizona, and extreme southeastern Utah, were justified, the temperature falling 16° to 20°, and to minima of 14° to 16°, over the area included in the warnings. Warning of a moderate cold wave for southern and extreme eastern New Mexico, issued on the evening of the 14th, was also justified, the fall in temperature east of the mountains in that State amounting to from 20° to 34°, with minimum temperatures at Santa Fe and Roswell of 8° and 22°, respectively, on the morning of the 16th.

Warnings of snow and a severe cold wave in eastern Colorado, and of snow and a moderate cold wave in northeastern New Mexico, including stockmen's warnings in eastern Colorado, were issued on the morning of the 17th, when a low of unusual intensity extended from the Southern Plateau States to the Upper Lakes, with its center over northeastern Colorado, while much higher pressures and severe cold weather prevailed over the sec-

tions to the northward. Cold-wave warnings, based upon 4 p. m. special observations, were extended to southeastern New Mexico on the afternoon of the 17th and were repeated on the evening of that date, when temperatures considerably below freezing were forecast for extreme southeastern New Mexico by the following morning. Moderately heavy snow fell in eastern Colorado during the afternoon and night of the 17th, with a severe cold wave overspreading northern and eastern Colorado by night and extending to extreme southeastern New Mexico by the morning of the 18th, when the temperature was below zero in northeastern Colorado and was but 16° above zero at Roswell, N. Mex. The fall in temperature in eastern Colorado amounted to from 34° to 40° during the 24 hours ending at 8 p. m. of the 17th, and at Roswell to 36° during the 24 hours ending at 8 p. m. of the 18th.

On the evening of the 20th, when an area of low pressure extended from southern California northeastward to the Upper Lakes, with its center near Pueblo, where the barometer had fallen to 29.22 inches, warnings of a moderate cold wave were issued for eastern Colorado and southeastern and extreme northeastern New Mexico. The fall in temperature during the following 24 hours amounted to from 20° to 36° over the region specified, with the minimum temperature on the morning of the 22d ranging from 4° at Cheyenne to 26° at Roswell.

Warnings of a moderate cold wave were issued on the morning of the 21st for northern and eastern New Mexico, with live-stock warnings for the northeastern portion of that State, due to expected snow and strong northerly winds. The cold-wave warnings were fully justified, as already indicated, with strong winds and rain, turning to light snow, in northern New Mexico during the 21st and the night of the 22d.

A cold wave, without warning, occurred at Grand Junction, Colo., on the 18th, and at Durango, Colo., on the 22d.

Frost warnings were issued as follows: 4th, extreme southern New Mexico and southwestern Arizona; 5th and 6th, extreme southern New Mexico and southern Arizona; 10th, 11th, and 14th, south-central New Mexico and southern Arizona; 12th, south-central New Mexico and south-central and southeastern Arizona; 15th, 21st, and 22d, southern Arizona; 16th and 23d, southern New Mexico and south-central and southeastern Arizona; 18th, southern Arizona; 19th, south-central and southeastern Arizona; 25th, 27th, and 30th, southern New Mexico; 31st, extreme southeastern New Mexico. These warnings were generally verified.

The following freezing-temperature warnings were also issued: 16th, 23d, and 26th, extreme southeastern New Mexico; 18th, south-central and southwestern New Mexico; 19th and 22d, southern New Mexico. All of the foregoing warnings were verified at Roswell, El Paso, or the fruit-frost stations in southern New Mexico, except that of the 26th, the lowest temperatures on the morning of the 27th being 36°.—*J. M. Sherier.*

SAN FRANCISCO FORECAST DISTRICT.

The dominant feature of March weather in this district was the persistence of a large and energetic area of high pressure off the northern coast. This condition deflected the storms from the north Pacific eastward at a high latitude, confined the areas of precipitation mostly to the western portions of Washington and Oregon, and caused a drought over the southern portion of the Pacific Slope.

On the 25th, the Pacific HIGH began to move inland and slowly developed a warm wave throughout this district from the 27th to the 29th, which broke records for high temperature in March at Sacramento and Portland and equaled the record at Roseburg.

On the 26th, radio reports from the *West Ivan* indicated the presence of a storm of considerable energy about 1,500 miles off the California-Oregon coast moving slowly eastward. On the morning of the 28th, Advisory messages were sent to all ports north of San Francisco, warning shipping bound for the Orient of the location and movement of the storm and that it would probably reach the northern coast about Friday evening (30th) and would later extend southward into California. This information was also given to the Associated Press, and was given marked prominence by the newspapers. The storm reached the northern coast Friday night and extended southward into California Saturday, breaking a drought which had prevailed for over a month. (See page 127.)

Storm warnings were ordered 15 times during the month as follows: On the California coast 8 times; on the Washington and Oregon coast 7 times. While some of these warnings were not verified by velocities reported at Weather Bureau stations, it is believed from radio reports received from vessels at sea, that they were all justified.—*G. H. Willson.*

RIVERS AND FLOODS.

By H. C. FRANKENFIELD, Meteorologist.

Owing to the low temperatures and numerous heavy snows of the winter without any rains or thaws of consequence, the inhabitants of the North Atlantic States were apprehensive of severe floods at the end of the winter. Over much of New England more than 90 inches of snow had fallen during the winter and the thickness of the ice in the rivers ranged from a few up to 30 inches. It was obvious, therefore, that a few days of rain or of warm weather, or both, would result in disastrous floods. Fortunately the heavy snows came so early that the ground had not frozen, but on the other hand absorbed much of the snow and kept it from the streams, which were low. It was equally fortunate that no heavy rains or high temperatures occurred in March, so that, when the ice in the rivers broke up, it moved out without serious incident. The only flood stage reported in New England was in the Connecticut and White Rivers at White River Junction, Vt., where there was a crest stage on March 24 of 15 feet, or 2 feet above the flood stage. The damage done was small. At Hartford, Conn., on the Connecticut River, the ice moved out on March 23, navigation by the aid of tugs having been opened on March 21.

Flood stages were also reached about the same time in the Mohawk, the north branch of the Susquehanna and the upper Delaware rivers, but with little resulting damage. In the West Branch of the Susquehanna there was considerable disturbance following the melting of the snow from the high temperatures of March 2, 3 and 4. The ice went out at Renovo, Pa., on March 2, and at Harrisburg, Pa., on the main river, on March 4 and 5. Much damage was done along the West Branch, especially to railroads, both steam and electric, manufacturing plants, merchants, etc. The ice gorged below Lock Haven, Pa., on March 3, and on the following day many

of the streets of the town were covered with water to a considerable depth, and railroad traffic was suspended.

The loss and damage amounted to \$60,000.

Warnings for all rivers were issued promptly as soon as the first indications of ice movement became apparent.

The heavy rains over the South Atlantic States about the middle of the month caused general floods that were well forecast. The floods, while more or less annoying, were not severe, and the total losses reported amounted to only \$16,690, while property to the amount of \$147,900 was reported to have been saved through the warnings issued by the Weather Bureau.

The Santee River of South Carolina remained in flood throughout the month.

The same general rains caused moderate floods in the Tombigbee, Pascagoula, and Pearl River systems of Alabama, Mississippi, and southern Louisiana, for which warnings were issued at the proper time. Apparently there was no damage of consequence.

The heavy rain area of the middle of the month extended northward over the Lake Erie and extreme southern Lake Huron basins, and in conjunction with moderately high temperatures caused some floods in the Maumee River of Indiana and Ohio and in the Flint and Pine Rivers of the Saginaw system of Michigan. Warnings were issued for the Maumee River and, while there was much inconvenience by seepage and sewer back-water, there was no damage of consequence. The Michigan floods were not of sufficient importance to require warnings.

Nothing of consequence occurred in the Ohio River or its tributaries east of Green River, Ky., but the main stream below Green River and all tributaries were in moderate flood for about ten days, beginning with March 13 in Green River and ending, as a rule, with March 28. All of the floods were forecast promptly and accurately. The damage was small, only \$36,000 loss having been reported, while the estimated value of property saved through the warnings was \$100,500. Also a considerable amount of property was saved, the actual values of which were not stated.

The Ohio River flood extended down the Mississippi River beginning with March 18 at New Madrid, Mo., and was in progress at the close of the month, but without promise of any unusual occurrences. All tributary streams from the Des Moines southward except the Missouri and Arkansas, were also in moderate flood, except in the Black and White Rivers of Arkansas, where the crest stages ranged from 2 to 9 feet above the flood stages. These floods were also well forecast and no damage was reported. In the Neosho and Arkansas Rivers of Oklahoma the rising waters caused damage to the amount of \$24,000 to new bridge construction, although flood stages were not reached. Special warnings had previously been sent to the construction companies.

Local floods in the Sabine, Neches, Trinity and lower Guadalupe Rivers of Texas were of minor importance, and the total reported losses amounted to \$10,000. The usual warnings were issued.

The ice gorges that formed in the Missouri River on March 22, at Sergeant Bluff, Iowa, and Decatur, Nebr., threatened for a time to produce disastrous results, but the absence of mild, rainy weather prevented a destructive overflow. The officials in charge of the Weather Bureau offices at Sioux City, Iowa, and Omaha, Nebr., moved with promptness, kept in intimate contact with the conditions, and through their timely and accurate warnings prevented the loss of a great quantity of movable prop-